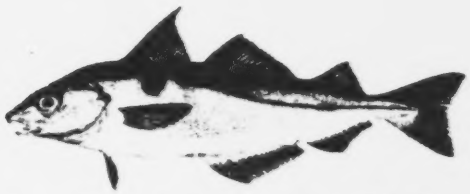
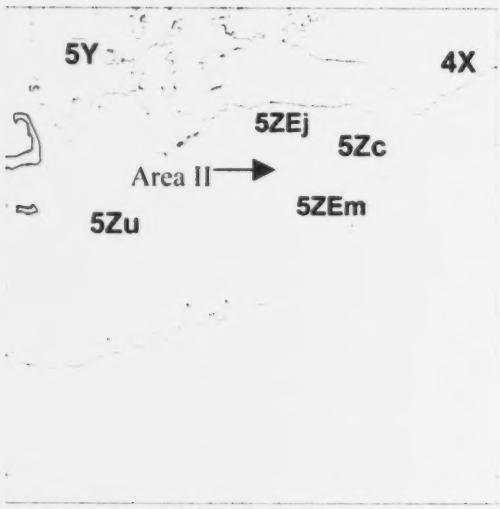


Eastern Georges Bank Haddock



Background

The haddock, a bottom dwelling species in the cod family, is found on both sides of the North Atlantic. In the western Atlantic, haddock range from Greenland to Cape Hatteras, with a major concentration on eastern Georges Bank.

Georges Bank haddock feed primarily on small invertebrates and are most commonly caught at depths of 45 to 240 meters (25 to 130 fathoms). Adult haddock appear relatively sedentary but seasonal movements occur. On Georges Bank, young haddock grow rapidly at first, reaching over 50 centimeters (20 inches) by age 3, but grow slowly thereafter, reaching about 75 centimeters (30 inches) by age 10. Many haddock mature by age 2 but it is uncertain if these young fish spawn successfully.

Georges Bank haddock have supported a commercial fishery since prior to 1900. Bottom trawlers have been the principal gear since their introduction in the 1920s. Landings from Georges Bank, which include the eastern Georges Bank component and the Great South Channel component, averaged about 46,000t between 1935 and 1960 and increased to over 100,000t in the 1960s under heavy exploitation. Subsequently, during the early 1970s, spawning season/area closures were introduced as a means of controlling effort and are still in use today. Following the extension of jurisdiction to 200 miles by coastal states in 1977, only Canada and the USA have fished this stock. Both Canada and the USA impose minimum fish size and mesh size regulations. Additionally, Canada establishes quotas to achieve a target exploitation rate of roughly 20% or lower of the harvestable population and the USA has instituted a year-round closure of Area II.

Summary

- Combined Canada and USA catches in 1999 were about 4,000 t.
- Exploitation has been below $F_{0.1}$ since 1995.
- Growth of adult biomass (ages 3+) is expected to be sustained during 2000 and the biomass will increase above 40,000 t, above which better recruitment has been observed.
- Biomass has increased since 1993 but remains below the 1930-55 average.
- VPA results suggest the 1996 year-class is the second strongest since 1978 while the 1998 year-class is the strongest. Early signs for the 1999 year-class indicate it may be the third strongest since 1978.
- A broad age structure is reflected in both the fishery catch and the population.

- There were no persistent trends in weight at age.
- The spatial distribution in the survey is similar to the recent past.
- Survivorship to age 1 is generally higher than that observed during the 1980s.
- The combined Canada/USA yield at $F_{0.1}$ in 2000 would be about 8,800 t and results in a probability of less than 30% of not achieving 20% biomass increase between 2000 and 2001.

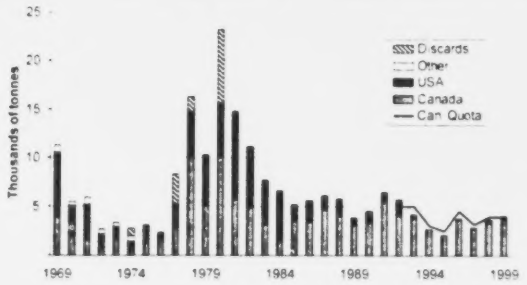
The Fishery

Catches (thousands of tonnes)

Year	1970-79 Avg.	1980-89 Avg.	1990-95 Avg.	1996	1997	1998	1999
TAC[1]	-	-	3.9	4.5	3.2	3.9	3.9
Canada	2.7	4.4	3.5	3.6	2.6	3.4	3.7
USA	2.8[2]	4.8[2]	0.8[3]	0.1[3]	0.1[3]	0.3[3]	0.4
TOTAL	6.1[2]	9.2[2]	4.3	3.7	2.7	3.7	4.0

[1]Canadian quota only
[2]Includes foreign catches
[3]Includes discard estimates

Under restrictive management measures, **combined Canada/USA catches** declined from over 6,400 t in 1991 to a low of about 2,100 t in 1995 and have since fluctuated between about 3,000 t and 4,000 t. Greater catches in the late 1970s and early 1980s, ranging up to about 23,000 t, were associated with good recruitment. Substantial quantities of small fish were discarded in those years. Catches subsequently declined and fluctuated about 5,000 t during the mid to late 1980s.



Total catches during the 1930s to 1950s ranged between 15,000 t and 40,000 t, averaging about 25,000 t. Catches probably attained record high levels of about 60,000 t during the early 1960s. Since the early 1970s catches have been substantially lower, generally fluctuating between 5,000 t and 10,000 t.

As in 1995 to 1998, **Canadian catches** in 1999 of 3,680 t were below the quota due to closure of the fisheries when the cod quotas were reached. During 1994 to 1999, all Canadian groundfish fisheries on Georges Bank remained closed from January to early June to protect spawning concentrations.

Weight of all Canadian landings were monitored at dockside, and at-sea monitoring by observers accounted for about 10% of the cod and haddock catch. In 1999, comparison of observer samples with port samples did not reveal any persistent patterns to indicate that discarding or highgrading commonly occurred. Discarding and misreporting have been considered negligible since 1992.

In recent years, the Canadian fishery has been conducted by vessels using otter trawls, longlines, handlines and gillnets. During 1999, all vessels over 65 ft operated on enterprise allocations, otter trawlers under 65 ft and fixed gear vessels 45-65 ft operated on individual quotas while fixed gear vessels under 45 ft operated on community quotas administered by local boards. Most haddock were caught by otter

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trawlers less than 65 ft and longliners less than 65 ft. The catches by otter trawlers peaked in June while catches by longliners peaked in August.

The size and age composition of the 1999 Canadian fishery was characterised by port and at sea samples from all principle gears and all seasons. The size composition of catch in the Canadian fisheries peaked at 53 cm (21 in) for both otter trawlers and longliners. Gill-netters caught few haddock but they were larger. No sampling was available for discards of groundfish by-catch in the Canadian scallop fishery, though in previous years the amount caught has not been large.

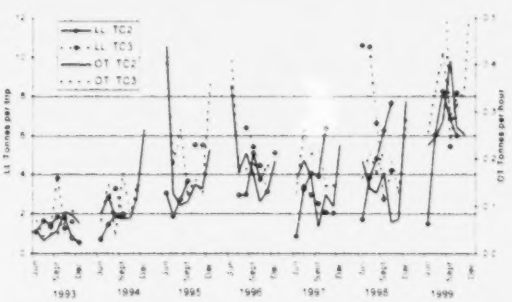
USA catches for 1999 were derived from logbooks coupled with dealer reports, as was done for 1994-98. Effort in the USA fishery was regulated using closed areas and Days-at-Sea limits. To curtail targeting of haddock, a 500 lb trip limit was introduced in 1994 and raised to 1,000 lb in July 1996. The trip limit resulted in an increase in the discard rate. The trip limit has been adjusted periodically and in 1999 it was established at 3,000 lb/day, maximum of 30,000 lb/trip during January through April, 2,000 lb/day, maximum of 20,000 lbs/trip during May through October and 5,000 lb/day, maximum of 50,000 lbs/trip during November and December. The combination of area closures, effort restrictions, and trip limits has precluded most operators from making long trips to 5Zjm, with the result that USA catches from 5Zjm have been low since 1993. While Area II remained closed in 1999, landings from 5Zjm increased to 355 t and discards declined because the day and trip possession limits were increased.

Available port samples were inadequate to characterise the size and age composition of the USA fishery catch from eastern Georges Bank. Length composition from the USA fishery in the Great South Channel area were used with Canadian fishery and DFO survey age-length keys from eastern Georges Bank to derive the catch at age.

For the **combined Canada/USA fishery catch**, in comparison to the age composition of the catch during various earlier periods in this century, age groups 3-8 were well represented in the 1999 catch. The 1996 year-class (age 3) dominated the 1999 catch. In contrast to pre-1994, few age 2 haddock were caught in 1999, due in part to the type of gear used and to avoidance of areas with small fish.

Resource Status

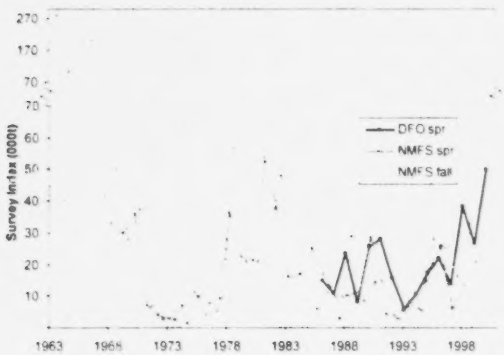
Catch rate from the Canadian commercial fishery for selected trips by tonnage class 2 and 3 otter trawlers and longliners increased from 1993 to 1995, remained relatively stable but variable from 1996 through 1998 and increased substantially in 1999. Changes to regulations, gear modifications and varying fishing practices in recent years make comparison of catch rates from year to year difficult to interpret. Therefore, these were not used as indices of abundance.



Surveys of Georges Bank have been conducted by the USA National Marine Fisheries Service (NMFS) each fall since 1963 and each spring since 1968, and by Canada's Department of Fisheries and Oceans (DFO) each spring since 1986. The spatial distribution of catches for the most recent survey of each series was similar to

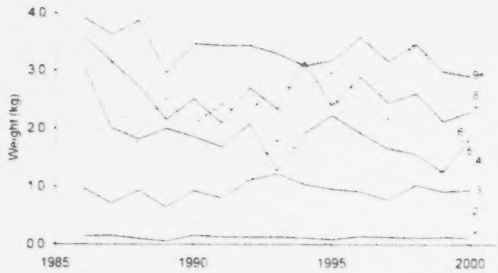
the distribution over the previous 5 year period.

The **index for ages 3-8 survey biomass** peaked at record highs during the early 1960s. After declining to a record low in the early 1970s, it peaked again in the late 1970s, though at a lower level, and again during the mid to late 1980s at about half the level of the 1970s peak. Biomass increased from 1992 to 1996, fluctuated somewhat and increased again after 1998.



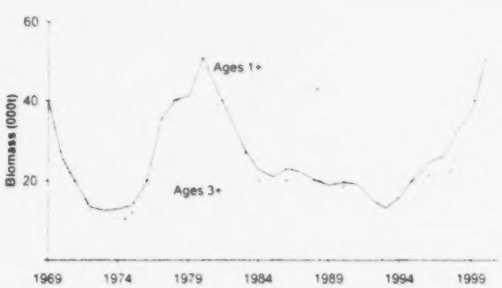
Survey recruitment indices for ages 1, 2 and 3 indicate that the abundance of the 1996 year-class was comparable to the moderate 1983, 1985, 1987 and 1992 year-classes. These year-classes were considerably smaller than the strong 1975 and 1978 year-classes and the very strong 1962 and exceptional 1963 year-classes. The 1997 year-class is weaker but the 1998 year-class may be moderate to strong. First indications for the 1999 year-class suggest that it may also be moderate.

There were no persistent trends in **weight at age** derived from the DFO surveys.



Stock status evaluations were based on a Virtual Population Analysis (VPA) assessment using catch statistics, sampling for size and age composition of the commercial catch, and trends in abundance from three bottom trawl research surveys.

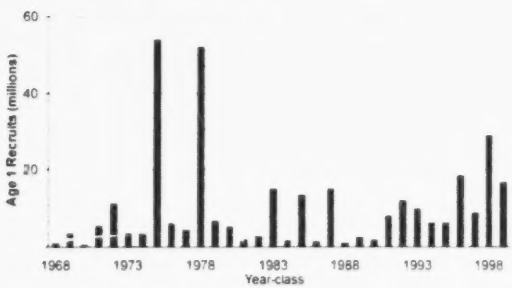
Population biomass (ages 1+), estimated by the VPA, has steadily increased from near historic low levels of about 13,000 t in 1993 to about 50,000 t at the beginning of 2000. The recent increase, due principally to the 1992 and 1996 year-classes, but also supported by the 1991 and 1993 year-classes, was enhanced by increased survivorship and by reduced capture of small fish in the fisheries. The biomass increase is expected to be sustained by the 1998 year-class. The adult biomass (ages 3+) trend is similar to the ages 1+ trend, with a 20% increase from 1999 to 2000, due largely to recruitment of the 1996 year-class.



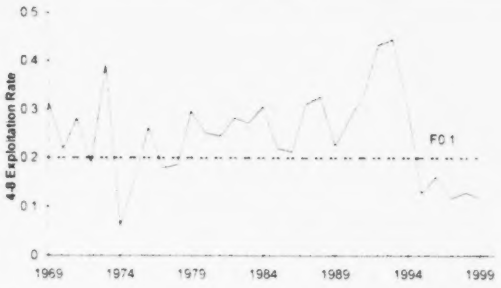
Population biomass during the late 1970s and early 1980s was almost 50,000 t, due to recruitment of the strong 1975 and 1978 year-classes whose abundance was estimated at about 50 million. However,

biomass declined rapidly in the early 1980s as subsequent recruitment was poor and these two year-classes were fished intensely at a young age.

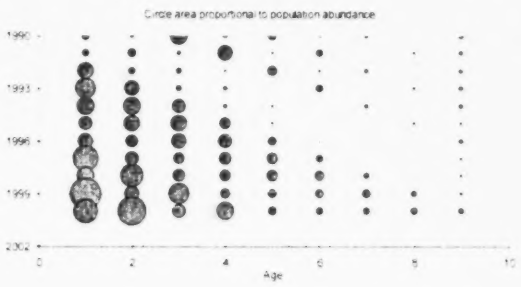
Recruitment, estimated by the VPA, indicated the strength of the 1996 year-class to be about 18 million at age 1, the second highest since 1978. The 1998 year-class was estimated to be relatively strong at about 29 million and is the strongest since 1978. Preliminary indications for the 1999 year-class suggest it may be the third largest since 1978 at about 16 million.



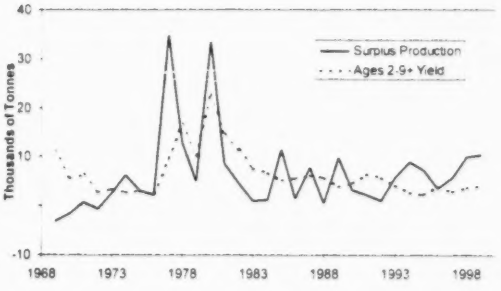
Exploitation rate for fully recruited ages 4-8 has consistently been below that corresponding to $F_{0.1}$ (20%) since 1995. Historically, exploitation rate has generally exceeded that corresponding to $F_{0.1}$ and showed a marked increase between 1989 and 1993 to almost 50%, the highest observed. Reduced fishing mortality in recent years has resulted in increased survival of incoming year-classes. The number of haddock of the 1992 year-class surviving to age 8 was over four times that of the equally abundant 1983 year-class, and about the same as that of the 1975 or 1978 year-classes which were more than 3 times as abundant.



In both absolute numbers and percent composition, the **population structure** displays a broad representation of age groups, reflecting improving recruitment and lower exploitation since 1995.



Since 1993, **surplus production** (biomass gains from growth and from recruitment, decremented by losses due to natural deaths) has exceeded the fishery harvest yield, resulting in net increase. Growth of fish is the dominant component of the biomass gain but recruitment accounts for significant portions when stronger year-classes enter.

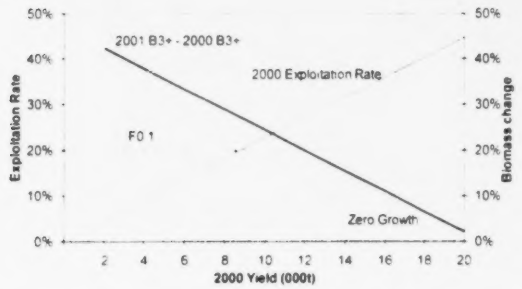


Assessments for several other stocks have identified a discrepancy between past and current estimates of stock status (retrospective pattern). This stock

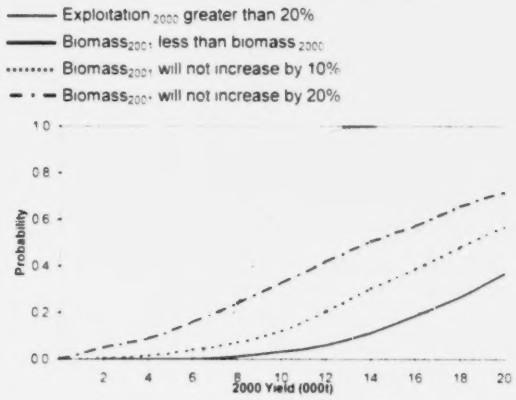
assessment does not suffer from a retrospective pattern.

Outlook

Projected total Canada/USA yield at an exploitation rate corresponding to $F_{0.1}$ in 2000 would be about 8,800 t. If fished at that rate in 2000, the adult biomass is projected to increase from 36,000 t to 46,000 t by the beginning of 2001. The 1996 year-class (age 4) is expected to comprise almost 40% of the total yield in 2000. The 1992-1995 (ages 5-8) and 1997 (age 3) year-classes will contribute almost equally for the remaining yield.



Uncertainty about year-class abundance generates uncertainty in forecast results. This uncertainty was expressed as risk of achieving reference targets. For example, a combined Canada/USA catch of 8,000 t in 2000, about twice what was caught in 1999, results in about 25% probability that fishing mortality rate will exceed $F_{0.1}$ and a low probability that the adult biomass will decrease. At this yield there is a probability of about 10% of not achieving 10% biomass increase and a probability of 25% of not achieving 20% biomass increase. A catch corresponding to $F_{0.1}$ in 2000 results in a probability of less than 30% of not achieving 20% biomass increase between 2000 and 2001.


Exploitation2000 greater than 20%
Biomass2001 less than biomass2000
Biomass2001 will not increase by 10%
Biomass2001 will not increase by 20%
Probability
2000 Yield (000t)

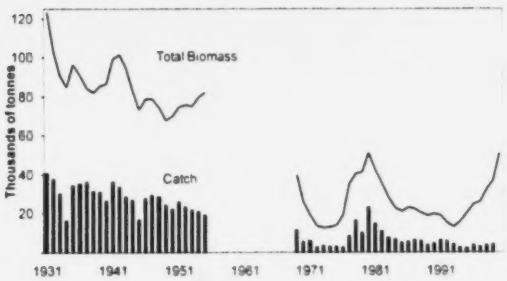
These calculations do not include uncertainty due to variations in weight at age, partial recruitment to the fishery and natural mortality, or systematic errors in data reporting and model mismatch.

Attributes like exploitation rate and biomass respond directly and immediately to management actions and can be used to compare consequences of alternative harvest yields. The projections above show those results. Other attributes, like recruitment, age structure and spatial distribution reflect possible fluctuations in the productive potential and can be used to qualify reference points and acceptable risk. Biomass can be considered both a response attribute and a productivity attribute. The states of these attributes suggests that while conditions have improved, further rebuilding is required, therefore some moderation is indicated.

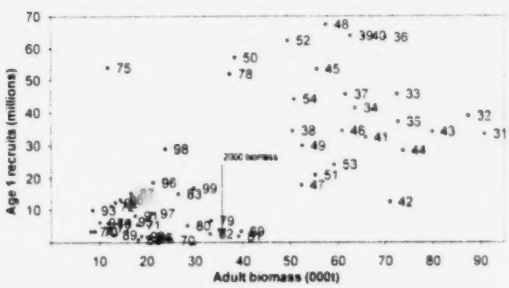
Management Considerations

The Canadian quota of 3,900 t in 1999 was expected to result in a negligible chance of exceeding $F_{0.1}$ and a 50% chance of getting 10% growth in the stock. The Canadian catch in 1999 was about 3,700 t and resulted in a fishing mortality about half of $F_{0.1}$ and an increase in adult biomass of about 20%.

Data were available to approximate the age composition of the catch from unit areas 5Zj and 5Zm in order to reconstruct an illustrative population analysis for the period between 1930 and 1955 which is suitable for comparing productivity. The results indicated that although biomass has been increasing, it remains below the average biomass during 1930-55 when productivity was higher.



The pattern of recruitment indicates that the chance of a strong year-class is significantly reduced for adult biomass below about 40,000 t. Since 1969, only the 1975 and 1978 (and possibly the 1998) year-classes have been near the average abundance of year-classes observed during the period 1930-55.



Examination of the recruits per spawning biomass ratio suggests that survivorship to age 1, for several years during the 1980s, may have been lower than the norm. The present survivorship appears comparable to that of the 1930s to 1950s period, suggesting that higher recruitment might result if the biomass increases.

The percent of biomass, ages 3-8, on the Canadian side of 5Zjm from the three surveys was summarised for recent years. During the NMFS fall surveys, almost all of the biomass occurred on the Canadian side. During the DFO spring surveys, generally conducted in late February, most of the biomass was on the Canadian side although the percentage was lower in 1992, 1993 and 2000. During the NMFS spring surveys, generally conducted in late March, the percentage on the Canadian side was typically lower but these results were more variable.

Percentage of biomass on Canadian side

	Spring		Fall
Year	DFO	NMFS	NMFS
1992	68	78	100
1993	67	43	99
1994	99	100	100
1995	98	62	100
1996	96	17	100
1997	92	93	100
1998	100	78	100
1999	98	41	100
2000	78	N/A	N/A

Cod and haddock are often caught together in groundfish fisheries. However, their catchabilities to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. With current fishing practices, exploitation of haddock at $F_{0.1}$ may compromise the achievement of rebuilding objectives for cod.

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Gavaris, S., and L. Van Eeckhaute. 2000. Assessment of haddock on eastern Georges Bank. DFO Canadian Stock Assessment Secretariat Res. Doc. 2000/082.

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